open to dispute and, with their brethren the mathematicians, generally prefer to begin a discussion by defining the terms they are about to use, unless such terms are already so restricted and definite in their meaning as to cause no doubt.

Failure to pursue this course is the basis of much idle talk and meaningless controversy, especially at the present time.

People are everywhere talking about an 'honest dollar,' or 'sound money,' without stopping to ask what a dollar *is*, or what is meant by 'money,' or a 'standard of value,' without inquiring what *is* 'a standard and what is meant by value,' and all of this to the confusion of many who would like to give serious thought to important subjects. As Major Powell's philosophy is to furnish a basis for the elementary concepts of physical science, he will not, I am sure, take it amiss if he is asked in the beginning to define with some care the principal terms of which he makes use. No physicist can fail to read his last paper with much interest and, it may be added, with no little astonishment. To one accustomed to the rather simple perspective of the so-called exact sciences, there is a sort of mistiness and obscurity in it which suggests an 'impressionist's' view of the subject.

It is true that in the beginning definitions of 'body,' 'particle,' 'molecule,' 'atom,' etc., are given, which are quite satisfactory as representing the meaning which the author proposes to attach to these words. But the physicists are put entirely out of the controversy by the failure of the author to tell or even hint at what he means by that which is the text of the whole paper, namely, *motion* itself. Major Powell undertakes to show that "motion is persistent," that it "cannot be created or annihilated," and he even goes so far as to declare that this has been demonstrated to the satisfaction of a great body of scientific men. He speaks, often, of 'motion as speed,' thus creating an anxiety to know what 'motion' is when it is not 'speed.' By 'speed' he evidently means 'velocity' as independent of direction, and he declares that 'motion as speed' is 'inherent in matter' and is not imposed upon it from without, from which it necessarily follows that it cannot be transferred from one system to another. Acceleration, he then says, must be considered as 'deflection' or change in that element of motion which is 'direction,' and not in any correct sense a change in velocity. No one will deny a considerable ingenuity in reaching this conclusion, but there are a few obstacles in the way which Major Powell will doubtless easily sweep aside, some of them being suggested in the following questions:

1. What is motion?
2. What is rest?
3. If by 'motion as speed' is meant 'velocity,' and if by its 'persistence' is meant invariability of velocity, what possesses this invariability?—bodies, molecules, particles, atoms?—and *in reference to what* is the velocity constant?
4. As a molecule is considered as a 'body' when reference is had to the atoms which compose it, can it have an 'invariable velocity' as a molecule and variable velocity as a 'body'?

Many other doubts suggest themselves which will probably be quieted by the answers to these questions. I cannot refrain from expressing a hope, however, that in addition to these answers, Major Powell will kindly furnish an explanation of what he means when he says that the transmission of light at the rate of 299,878,000 metres per second furnishes an example of 'particle motion at a velocity so great that any observed molecular motion sinks into insignificance.' M.

March 23, 1896.

PRINCIPLES OF MARINE ZOÖGEOGRAPHY.

I have been much interested in the admirable review, by Dr. Baur,* of Dr. Ortmann's 'Grundzüge der marinen Tiergeographie,' which I had only previously known from the 'summary' given in 'the Princeton College Bulletin' (VII., pp. 100–107); since then I have had the pleasure of receiving the work itself from the learned author. I find similarity in some features and difference in others between the views of Dr. Ortmann and my own. My contributions to zoögeography appears to have been unknown to Dr. Ortmann, except at second-hand, although exact references were made to publications by Dr. Faxon (p. 233), through

*Science, N. S., III., 359–367, March 6, 1896.

whom he obtained information.* This is the more regrettable because the similarity between Dr. Ortmann's conclusions and my own is more manifest than that between his and any other investigator's.

The differences between Dr. Ortmann and myself chiefly result from our different modes of approaching the subject. Dr. Ortmann prefers the deductive mode and teaches that "we are to disregard each definite group of animals, and to investigate only the *physical* conditions influencing the distribution."† I prefer the inductive mode and have been influenced mainly by the consideration of the assemblage of the several groups of animals.

Dr. Ortmann, in accordance with his views, recognizes five 'life-districts,' distinguished as follows:‡

"1. Light. The medium is air. Substratum present. Terrestrial district.

"2. Light. The medium is fresh water. Substratum present. Fluvial district.

"3. Light. The medium is salt water. Substratum present. Littoral district.

"4. Light. The medium is salt water. Substratum wanting. Pelagic district.

"5. Dark. The medium is salt water. Substratum present. Abyssal district."

While there is a symmetry in these definitions that may be attractive, analysis will demonstrate that the 'districts' themselves are of very unequal value. In fact, they are framed in contravention of another principle enunciated by Dr. Ortmann: "The topographical continuity of the range is a fundamental principle influencing the dispersal of animals."§

Now, there is no greater interrupter of topographical continuity for land or fresh water animals than wide intervening oceans, and inasmuch as such land areas, with varying limits, have existed for long geological periods, they have been more effective barriers to extension of inland life than the differences connected with the several districts whose 'medium is salt water.' The land and fluvial faunas have consequently been long differentiated and, although in every age there has been doubtless an invasion from the sea into the rivers, the bulk of the fresh water forms in most regions has been long settled and specially developed as such. The districts in question must therefore be segregated under two primary categories, MARINE and INLAND.

But the marine districts still left are likewise of very unequal value. They are distributed by Dr. Ortmann as follows:

"I. Littoral life-district. 1. Arctic region. 2. Indo-Pacific region. 3. West American region. 4. East American region. 5. West African region. 6. Antarctic region."

"II. Pelagic life-district. 1. Arctic region. 2. Indo-Pacific region. 3. Atlantic region. 4. Antarctic region."

"III. Abyssal life-district. No regions distinguishable."

These 'districts' and 'regions' would answer well to divisions which I have established as follows:

I. Arctalian realm (1875) = I, 1.

II. Tropicalian realm = Tropical zone (O.), I, 2+3+4+5.

III. Notalian realm (1875) = I, 6.

IV. Pelagalian realm = II.

V. Bassalian realm = III.

These combinations appear to me to better represent the facts known respecting the distribution of marine vertebrates as well as invertebrates. The first three were distinguished as early as 1875,* but not named till 1877.† Later I deemed it advisable to subdivide the Arctalian into Arctalian (restricted) and Pararctalian and the Notalian into Antarctalian and Notalian (restricted). I also added the Bassalian and still later the Pelagalian. The Pararctalian and Notalian proper have less value than the others, except the Pelagalian, which is the least specialized of all.

I have thus pointed out the chief differences between Dr. Ortmann's views and my own. Naturally, from the difference in our starting points, ensuing differences are great. Dr. Ortmann's method leads to a consideration of 'life

* Grundzüge, p. 59.

† Pr. Coll. Bull., VII., 103.

‡ Pr. Col. Bull., VII., 101.

§ Pr. Col. Bull., VII., 102.

* On the geographical distribution of fishes, *in* An. Mag. Nat. Hist. (4), xv., 251–255, Apr., 1875.

† Wallace's Geographical Distribution of Animals *in* Nation, xxiv., 27, 28, 42, 43, July 12, 19, 1877.

districts' as affected by their animal inhabitants; mine to the aggregations of animals according to their habitats.

The differences are counterbalanced by the resemblances in other respects. Let me close then by endorsing the favorable criticism of Dr. Ortmann's work by Dr. Baur and commending it as well worthy of attention.

THEO. GILL.

RÖNTGEN RAY EXPERIMENTS.

EXPERIMENTS with Röntgen Rays have been carried on very persistently at Case School of Applied Science for several weeks, and some very interesting results have been obtained. The main object has been to secure good photographs of the human skeleton in a living subject, and to increase the practical efficiency of the apparatus. The accompanying photographs of the bones of the hand and forearm, and of an aluminium medal, will indicate the degree of success obtained.

The arm was photographed with an exposure of twenty minutes, while the medal ($\frac{1}{16}$ inch thick) required but five minutes. The Crookes tube used is of the well-known spherical form, having four electrodes, designed to show that the discharge in a high vacuum is independent of the anode, and is one of a set which was exhibited at the World's Fair. It was excited by an induction coil giving about a six-inch spark in air, when using a current of three amperes and twenty volts, obtained from eleven cells of storage battery. The arm was held by bandages to the plateholder, which was supported in an inclined position upon a special stand. The usual plateholder slide of hard pasteboard was between the hand and plate. The tube was placed at a distance of twelve inches above the wrist. Rapid plates were used and developed in the usual way with eikonogen and hydrochinon developer. Slow lantern slide plates give nearly as good results, indicating that the sensitiveness of the plate to ordinary light is no criterion in this work. A great deal of detail appears plainly during development which disappears in the 'fixing' process. Various kinds of developers and fixing agents have been tried to overcome this, without success.

A photograph showing the bones of the fingers has been made with ten seconds' exposure, the tube being two inches above the plate. The bones of the entire arm, including the shoulder joint and of the foot, have been satisfactorily photographed. Attempts have been made to photograph the chest and head with exposures of one hour in each case, the tube being eighteen inches from the plate. The resulting negatives show a surprising amount of detail, which is too faint for satisfactory reproduction. The chest picture shows eight ribs on each side of the spinal column, a dark streak in the latter corresponding to the spinal cord. Under the region of the heart the ribs do not show, indicating that the heart is more opaque than the lung tissue. The collar bone is prominent, while the details of the shoulder joint can be seen. The picture of the head shows the following details: The spinal column in the neck, the jaw bones, with teeth and spaces where several are missing, the nasal cavities, the thickening of the bone showing clearly the outline of the ear, the thin places at the temples, the floor of the brain cavity and the ragged edge where bone and cartilage join in the nose. These pictures, though of little surgical value, are very interesting experimentally. Some of the negatives made clearly show the ligaments connecting the bones at the joints, while none have so far shown any blood vessels or nerves.

Bullets have been located in the hands of four men, and numerous cases of hands injured by machinery and of deformities have been examined, the exposures varying from two to twenty minutes. Some very interesting and valuable pictures of diseased arm bones and of fractures of the arm have been taken. In one case four inches of the arm bone had been removed five years ago, and the extent of the disease is clearly shown. Views of the fractures where the ends of the bones are not in apposition are of value to the surgeons. These photographs are taken through bandages, splints and silicate of sodium casts without hindrance.

A most interesting study has been the position of the various small bones of the wrist in different positions of the hand.

Many interesting points are noted in the work, which are suggestive in a theoretical way, details of which are not ready for publication.